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DEPARTMENT OF THE INTERIOR

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JOHN W. FINCH, DIRECTOR

INFORMATION CIRCULAR

SOME OBSERVATIONS AS TO SAFETY HAZARDS IN 47 NORTHERN COLORADO SUBBITUMINOUS COAL MINES

BY

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SOME OBSERVATIONS AS TO SAFETY HAZARDS IN 47 NORTHERN COLORADO SUBBITUMINOUS COAL MINES[1]

By E. H. Denny[2]

During 1934 the United States Bureau of Mines through the Denver office of the Safety Division cooperated with N.R.A. Divisional Coal Code Authority Division V, District 1 (Northern Colorado producers) in sampling 47 northern Colorado subbituminous coal mines; the work presented an excellent opportunity to observe operating and safety conditions and practices in this group of relatively small mines. This paper deals chiefly with safety conditions. The sampling was done to assist the code authorities in the classification of coals; analyses of the samples were made by the coal laboratory of the Bureau at the Pittsburgh (Pa.) Experiment Station and are appended hereto.

NORTHERN COLORADO COALS

The term "northern Colorado coals" used in this report refers to coal mined in Boulder, Weld, Jefferson, El Paso, Jackson, Larimer, and Elbert Counties, Colo., all of which is subbituminous and relatively high in moisture content. In 1933 the total coal production[3] of the counties listed was 2,417,757 tons.

The coal produced is consumed largely in Denver and adjoining counties and by the railroads of the district. The distance to which it can be shipped out of the State is limited to some extent by the ease with which it slacks and fires on exposure to air.

All the larger producers except one are shaft mines, the shafts ranging up to 788 feet in depth. Coal is mined by the room-and-pillar system, and pillars are largely extracted.

The coal is cut by machines and sometimes sheared as well. Mechanical loading is just being introduced in the field. Where the thickness of the coal permits, 16 or more inches of roof coal are left for roof support, as the main roof is usually poor-quality shale.

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[1] The Bureau of Mines will welcome reprinting of this information circular, provided the following footnote acknowledgment is used: "Reprinted from U.S. Bureau of Mines Information Circular 6862."

[2] District engineer, Safety Division, Health and Safety Branch, U.S. Bureau of Mines, Denver, Colo.

[3] Report of Colorado State Coal-Mine Inspector.

The coal beds in the larger mines usually are nearly flat with local irregularities; the western part of the field pitches sharply and is almost vertical in a few openings. Faulting is extensive, and sometimes the displacement prevents extension of the mine workings. The geology of the field is described in publications[4] of the United States Geological Survey. Mining practices of some of the larger mines are described in Bureau of Mines Report of Investigations 3199.[5]

OBSERVATIONS ON HAZARDS IN MINING OPERATIONS

Underground and surface sampling of the 47 mines presented an opportunity to observe and inquire into mining conditions with particular reference to safety. Excellent safety practices were in vogue at many of the mines; good practices, however, are not discussed in this report. In the smaller "wagon" mines safety conditions and practices varied widely. Conditions naturally were better in those small operations manned by experienced miners. A number of such mines have very capable and experienced officials and miners; many of them, however, are operated with scanty equipment and little capital under adverse natural mine conditions by men striving to avoid relief rolls, who expose themselves and their fellow workers to considerably more hazards than would confront them in well-planned and equipped mining operations. Some of these hazards can be minimized readily; others can be abated or eliminated only by considerable expenditure. It seems questionable whether men for the sake of a meager living should risk or be allowed to risk life and limb and the welfare of their dependents without the ordinary safeguards commonly accepted in most mines through experience.

The substandard or unsafe conditions or practices detailed below were observed in one or more mines. All these conditions and practices do not obtain in any one mine; most of them prevail in the smaller mines and are sufficiently widespread to warrant the conclusion that much improvement is desirable in the smaller mines as a class. A few notes apply to mines in the Southern Colorado field visited during the year. Much more time and opportunity were available in the smaller than in the larger mines to examine and observe conditions while sampling.

Roof Hazards

Falls of roof and face account for about half of the coal-mine fatalities underground and a large proportion of the broken backs and other serious injuries received in all coal mines. Most of these could be prevented by adequate timbering placed when and where needed and by barring down loose and drummy material. The following are extracts from notes on individual mines:

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[4] Emmons, S. F., Cross, Whitman, and Eldridge, G. H., Geology of the Denver Basin in Colorado: Mon. U.S. Geol. Survey, vol. 27, 1896.
Martin, G. C., Coal of the Denver Basin; Coal Fields in Colorado and New Mexico: U.S. Geol. Survey Bull. 381c, 1908, pp. 297-306.

[5] Tomlinson, H., A Study of Falls of Roof and Coal in Northern Colorado: Rept. of Investigations 3199, Bureau of Mines, 1933, 20 pp.

> Timbering throughout the parts of the mine traveled was inadequate and was set in a makeshift manner.
>
> Roof conditions appeared to be dangerous in several working places, particularly where the immediate roof was shale.
>
> Overhanging draw slate is a hazard and should be cleaned down more carefully.
>
> For the limited amount of development roof conditions were particularly bad. The roof of one main entry contained a large piece of loose roof coal weighing half a ton or more; the other entry roof contained a piece of draw slate about 18 inches by 5 feet by 10 feet which had partly separated about 4 inches from the sandy shale roof. The oldtime miners working nearby and tramming under the loose slate planned to take it down when they had time and inclination.
>
> In a mine employing normally about 100 men "falls had occurred in 3 rooms over Sunday spanning the entire roadway and extending 15 to 20 feet in length." Crossbar sets should be placed at close intervals.
>
> In collecting samples at a small operation the author had to crawl over 5 major falls in the main entry, and during the sampling 3 or 4 tons of roof fell near by, knocking out 2 sets of timber. Anything is used for timber from old ties to cottonwood. No roadhead props are used. The roof is a poor spongy slate which slacks readily and should be timbered systematically. However, the operators prefer to timber scantily and spend considerable time cribbing in order to continue operations.
>
> In various places throughout the mine dangerous roof conditions caused the three men working underground no concern.
>
> The timbering agreement with the State mine inspector calls for timber on 5-foot centers. A number of places do not comply with this, and more timbering is needed than that required by the agreement. Serious roof-fall accidents occurred recently in this large mine.

Haulage Accidents

Haulage accidents result in many permanent partial disabilities and fatalities.

The following notes are abstracted from reports of haulage conditions observed in small mines each having one or more of the following unsafe practices or conditions:

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In one mine a surface derail switch on the slope is spiked closed. The main-slope man-clearance is insufficient, and no manway is provided.

Mine cars are badly in need of repair. No derailing device is used at the top of the main slope.

The one mine car used for haulage lacks half of a bottom board and an entire end board.

There is no track in the mine; a box with sheet-metal bottom holding about half a ton of coal is pulled to the surface by an automobile engine and cable.

The hoist rope passes from the hoist by a series of sheaves along the ground to the foot of the tipple with some hazard to passersby. No drag is used on the slope, and there is no derail. Switches are of the foot-throw type.

Bony coal and rock gobbed along the slope leave insufficient man-clearance. The hoist landing indicator was not in use, the position of the trip being gaged by the turns of rope on the drum.

The hoist cable is in very poor condition and is also badly in need of greasing. Broken strands are frequent throughout the cable length.

The bell system is a jerk-line from the bottom of the shaft to a bell at the shaft mouth. The signals heard at the hoist 75 feet away were easily mistaken. The indicator on the hoist probably will be put in working order.

The skip cable showed considerable wear from nonuse of rollers or sheaves on the slope.

Cars are not in good repair, and the track is rough and uneven.

During hoisting on the slope the rope whips about, involving hazard to persons traveling the slope, and the man-clearance on the slope is limited.

Safety catches are not installed on the cage, and overwind devices are not used. An improvised bell system is usually supplanted by shouting from the shaft bottom. Six-pound rails are used.

Hoisting from the shaft is by a horse-drawn windlass without a brake. The harness on the horse is old and in poor condition. Cages are counterbalanced. Underground tramming is done by hand, and as the low entries are not brushed men crouch on their knees

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while pushing cars. Most of the track in the mine is of 2-inch by 4-inch boards. No room switches are used, cars being lifted off the entry track and turned onto the room tracks.

Insufficient man clearance was noted between the loaded track and the rib near the shaft bottom at this large mining operation.

At one medium-size operation the floor in parts of the mine was heaving, and in places one side of the track was a foot higher than the other side. The cars were not in good repair, and spillage of coal was excessive.

At another medium-size operation the track was crooked and rough. The haulageway was badly "cluttered up" with coal and rock which made walking difficult. Many of the cars were in need of repair. Considering the condition of the track, the man-trip should travel more slowly. Cagers wisely keep their distance during coal hoisting because of coal spillage down the shaft.

In one large mine miners top their cars excessively, with the result that a great deal of coal is spilled along haulageways.

Over 600 feet of the roadbed was ankle deep in mud, and in some places the rails were under water. A number of falls were noted along haulageways, and timbering was done in makeshift fashion. In several places the crossbars had taken so much weight that the mule had to step outside of the track in order to pass under. Several broken strands were noted in the slope hoist rope.

Five of the smaller mines visited used automobile motors for hoisting coal, and one used a steam-operated thrashing tractor for operating a hoist and compressor. Considerable ingenuity was manifested in the adaptation of these motors to haulage of coal. Most of them handle one 1-ton car of coal. Usually these motors are not suitable because of insufficient speed control and lack of overwind device. In one instance the automobile motor drove a drum of a hoist which was equipped with a hand brake; and a brake lever extended from the automobile motor-drive shaft to the hoist operator's position.

Ventilation and Gases

Methane gas has been encountered occasionally in some of the larger mines of the northern Colorado field, although detection of methane is rather uncommon. It has been ignited on several occasions, burning men. Closed lights are used in most of the larger mines with "no-smoking" rules, and fireboss inspections are required. Carbon dioxide and nitrogen mixtures (black damp) are much more common than methane. Black damp is formed quite readily by absorption of oxygen or oxidation of subbituminous coal. The larger mines are ventilated by relatively large-capacity fans, but in some of these the circulation of air in room entries is noticeably sluggish because too much reliance is placed on leaky doors in slants, and canvas brattice is used too freely and installed loosely in numerous room and entry crosscuts.

The following notes illustrate common occurrences of black damp or carbon dioxide when ventilation is inadequate or improperly directed.

> In two working faces in small mines black damp was found in percentages high enough to affect a carbide lamp. It is understood that the fan is shut down after operating about an hour each morning.
>
> In most of the faces visited the ventilation was very poor, and the black damp present affected the carbide lamps. An attempt to inspect the sump failed because the superintendent's carbide lamp would not burn due to black damp present.
>
> Whenever the barometer drops, enough black damp is forced out of the old workings to extinguish the workers' carbide lamps.
>
> Recementing of cracks in stoppings is frequently necessary to prevent the admission of fumes from the fire to the main slope.

In a number of the smaller mines substandard ventilation practice is common; 8 small northern Colorado coal mines and 2 small coal mines in other parts of the State relied solely upon natural ventilation. It is true that these mines were operating only a short distance from surface openings, but unquestionably conditions in these mines are such that good circulation of air induced mechanically is essential for safety against black-damp accumulations. In the event of fire natural ventilation is likely to reverse and imperil men, as illustrated by the loss of a number of lives in northern Colorado; a mechanically induced air current can be utilized in directing the air in fighting fire and sealing off fire areas and offers a better chance for the men to escape than natural ventilation. In several mines the fan was said to be operated intermittently or shut down at night to save power costs; this practice permits gases from old workings or sealed-off fires to impede the work of the mine and endanger the men. One mine had a number of rooms turned but had only one opening, a shaft; it was ventilated by blower and tubing. Two instances of considerable air leakage were noted at the fan from leaky fan housing; much of the air intended for the mine was short-circuiting at the fan.

Fire Hazard

Reference has been made to the generally recognized hazard of spontaneous ignition of subbituminous coal. Nevertheless, most of the mines, both large and small, lack underground water lines to or near the faces for prompt combatting of fires. So far as known only one northern Colorado coal company owns modern oxygen breathing-apparatus equipment, and this was not being maintained

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ready for use. The United States Bureau of Mines maintains oxygen apparatus and gas masks on a truck and temporarily on a railroad mine rescue car at Denver; this apparatus is used frequently in remote parts of Colorado or outside the State. Training of northern Colorado coal miners in the use of this equipment had been almost completely abandoned owing to company economies and the Bureau's lack of funds for this work, but in the spring of 1935 some training was conducted through the cooperation of mining companies, the State of Colorado, and the United States Bureau of Mines. Fortunately most of the many fires occurring in subbituminous mines develop slowly, and heated areas and fire areas are usually sealed without great difficulty.

In pitching coal operations it was observed that much coal was left on the hanging and foot walls. Later falls of coal leave fine coal in the room necks which is likely to ignite; sometimes not enough thought is given to laying out workings to facilitate sealing of such likely fire areas. In some operations considerable gobbing of fine coal in rooms adds to the danger of spontaneous ignition.

The natural fire hazard is frequently enhanced by nonfireproof construction and poor housekeeping. Some wooden tipples had poorly hung, open electric wiring and little or no fire protection. Spillage of oil and grease and accumulation of combustible debris are common in and about these tipples. In one instance hot ashes were used for the tipple foundation, and the waste dump was burning within 25 feet of the wooden tipple. The wooden joists of the fan building were largely soaked with oil. Surface buildings of timber construction are sometimes located so as to form a fire hazard to men underground. In some instances wooden fan buildings and connections to airways present a hazard in that fumes might be drawn into the mine from a surface fire at or around this fan. Several dry timbered hoisting shafts were adjacent to wooden surface structures; in one mine such a shaft was the only exit.

The common use of granular black blasting powder and pellet powder in the field also introduces an additional hazard in firing coal. At least one recent fire is thought to have started from a shot of pellet powder; unquestionably numerous fires are caused by this unsafe method of coal-mine blasting.

Many companies keep fire extinguishers in surface buildings, but some of these extinguishers are not types approved by the Fire Underwriters and probably would be effective only in incipient fires.

Surface fire protection ranges from numerous hydrants and hose and good water pressure at some mines to no fire protection at many of the smaller properties.

In two small mines hay was scattered in and about the underground stable and the adjacent entry, constituting a fire hazard, and in one large mine apparently excess hay was stored underground.

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Explosives

This work afforded little opportunity to observe explosives practice. Pellet powder, granular black blasting powder, and permissible explosives are used in the mines. Shooting commonly is done at the close of the shift or at noon (or both) by shot firers or miners. In general, coal is cut and also sheared; some solid shooting is practiced in the smaller mines.

At one small mine gelatin dynamite, detonators, and pellet powder were stored together in a surface magazine. In two mines explosives and detonators were kept together in a powder box. In another prepared primers and 20 sticks of explosives were in a box on the entry close to the track.

At two of the larger mines holes had been loaded before the place was undercut, and during the slack season loaded holes are sometimes not fired for several days. Such practices result in blown-out shots, possible explosions, and misfires and the numerous hazards accompanying their handling.

Several large and small mines used coal-dust drillings and slack coal for stemming holes.

Transportation of explosives in a second trip closely following the mantrip was reported in one large mine. In a small mine unboxed pellet powder and fuse were transported on a cage carrying 4 men wearing burning carbide lamps.

Dust

The haulage roads, manways, and air courses of several large and small mines were very dusty in places. Inasmuch as heavy blasting with granular black blasting powder has been practiced in northern Colorado for many years without reported instances of dust ignition mine operators consider that there is little or no danger of dust explosions. Tests of Wyoming subbituminous coal by the Bureau of Mines have shown that fine coal dust can be ignited by a blown-out shot of black blasting powder and produce a general explosion. More study is needed to determine what factors are involved in the apparent immunity from dust explosions of the northern Colorado subbituminous mines; meanwhile much more caution should be exercised than at present in the use of explosives in these mines. If a dust explosion should occur in a high-moisture coal of northern Colorado it probably would be started by the ignition of a considerable body of gas or by an electric arc in the presence of a large dust cloud from a wrecked trip or from the ignition of a considerable amount of explosives. Dust accumulations should not be disregarded but should be brushed or washed from ribs and timbers, and roadways should be cleaned regularly and as completely as practicable. Rock-dusting of these mines, especially those that are definitely dry, is desirable but is not likely to be practiced until after an explosion occurs.

Dust accumulations were noted in tipples, and two instances of spontaneous ignition of fine dust in a tipple were reported.

Electricity

Power for trolley locomotives and coal-cutting machines is commonly 250 and 440 volts potential. In some mines the trolley wires are well-guarded at places where men have to pass under them, as at branch entries and shaft bottoms; but even at such locations guards are often lacking, with consequent danger of electrocuting men. So long as men are exposed to unguarded trolley wires or power lines occasional loss of life is unavoidable. Some metal mines as well as a few coal mines have found that boxing the trolley wire throughout the mine is feasible and that the added protection to life pays in dollars and cents and in the prevention of suffering and misery.

In both large and small mines instances of substandard wiring on the tipple and underground were reported; substandard practices include wires touching timbers and coal, wires poorly supported, wires hung on nails or wooden wedges or wrapped around posts instead of on insulators, bare spots for connection to machine cables, and poorly insulated splices in cables and wires, often where clearance is limited and lighting inadequate. Such wiring is common in and about many coal mines of the United States although it would not be tolerated in industrial plants or city residences and should not be allowed in any kind of mine.

Miscellaneous

Some of the larger mines apparently lacked adequate supervisory force during the depression; at some of the smaller mines the underground foreman performed many duties underground, on the surface, and in town. Even with the present supervisory force, much more attention could and should be given to safety practices.

In some mines protective hats are used by all; in others there are none. In some mines goggles are commonly used in picking operations; at others where the miners are supposed to use goggles few or none were noted. Protective shoes are used only to a limited extent.

No check-in-and-out system is reported at one small mine.

First-aid material is usually available at least in the mine office, but one small mine had none.

At least two of the small mines are said to have no maps of the underground workings.

Poor plant maintenance was evident at several large and small mines.

Many surface and underground machines were unguarded or improperly guarded.

One underground-to-surface telephone system was not working, and a fire-boss vacancy at this mine had not been filled.

Inquiry at some small mines employing more than 4 men indicated that no compensation was carried.

In numerous instances substandard conditions and practices have been condemned by State mine inspectors and orders issued for their rectification, but the limited travel funds of the State department have made the prompt carrying out of such orders difficult or impossible. For mines that definitely come under the certified-foreman provision of the mining law (mines employing three or more men underground) the State has been fairly successful in obtaining a responsible supervisor in most cases.

CONCLUSION

As previously stated, the unsafe conditions and practices discussed herein do not obtain at all mines visited. Some small and some large mines have excellent safety conditions and practices. Good conditions and practices should be more universal, and conditions could be improved in many particulars with little present and probably no ultimate cost. Perhaps mines where capable men are employed with limited and poor equipment and working under adverse natural conditions could be combined to make better mines. It certainly does not benefit the public welfare for mining operations to expose men constantly to unnecessary hazards, with resulting loss of life or injury to be paid for ultimately by the State and its citizens.

The appended tabulations summarize the coal analyses made in connection with the sampling in this study; the analytical work was done by the coal laboratory at the Pittsburgh (Pa.) Experiment Station of the United States Bureau of Mines. Table 1 summarizes the data on face samples taken in the mines, and table 2 gives similar data from tipple samples, both the face sampling and the tipple sampling being according to Bureau of Mines standard methods.

TABLE 1.- Analyses of Mine Samples, Northern Colorado Coals

Where mined			Number of samples mixed and analyzed	Date sampled	Moisture, as received	Dry coal								B.t.u., as received	B.t.u., dry coal	B.t.u., ash- and moisture-free	Softening temperature, °F.
County and town	Mine	Bed				Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen				
Boulder County																	
Erie........	Arrow (Star).	Unnamed.	2	4/5/34	23.8	36.3	57.4	6.3	.6	4.7	72.1	1.7	14.6	9500	12460	13300	2305
Lafayette...	Black Diamond.	do.	4	3/26/34	21.5	38.0	56.3	5.7	.5	4.8	72.0	1.6	15.4	9790	12470	13220	2100
Gorham......	Crown....	do.	3	3/29/34	18.3	39.0	55.9	5.1	.4	4.9	71.8	1.6	16.2	10130	12400	13060	2175
Do.	Eldorado.	do.	3	3/12/34	19.1	39.0	55.5	5.5	2.0	4.8	70.2	1.1	16.4	9950	12300	13010	2120
Louisville..	Fireside.	do.	3	3/20/34	21.2	36.0	57.0	7.0	.6	4.7	71.4	1.4	14.9	9740	12350	13230	2100
Superior....	Gorham...	Gorham..	2	3/8/34	19.7	38.6	56.2	5.2	.4	4.6	71.9	1.5	16.4	9970	12420	13100	2145
Lafayette...	Hiway....	Boulder.	3	11/5/30	19.9	38.9	56.2	4.9	.4	4.9	73.5	1.6	14.7	10220	12760	13410	2175
Superior....	Industrial.	Unnamed.	4	11/3/32	18.9	37.4	57.1	5.5	.3	4.9	72.8	1.5	15.0	10110	12460	13190	2160
Gorham......	Lewis No. 2.	do.	3	3/19/34	18.4	39.6	54.6	5.8	1.5	5.1	70.6	1.2	15.8	10260	12560	13340	2230
Broomfield..	Monarch No. 2.	do.	4	6/18/34	19.6	38.0	57.2	4.8	.4	4.9	72.1	1.6	16.2	10130	12600	13240	2210
Lafayette...	Paramount	do.	2	3/23/34	20.5	38.9	54.3	6.8	.8	4.8	70.5	1.4	15.7	9780	12310	13210	2130
Gorham......	Pine Cliff.	do.	2	3/15/34	18.7	37.6	55.1	7.3	1.1	4.7	69.6	1.2	16.1	9890	12170	13130	2100
Superior....	Pluto....	do.	2	3/6/34	19.3	37.5	56.7	5.8	.5	4.7	72.2	1.5	15.3	10020	12430	13190	2120
Gorham......	Red Ash..	do.	2	3/29/34	18.9	37.4	56.1	6.5	1.2	4.7	70.5	1.2	15.9	9910	12220	13060	2090
Do.	Rosser...	do.	2	3/16/34	19.8	39.0	56.0	5.0	1.1	4.8	71.9	1.1	16.1	9990	12450	13100	2230
Elbert County																	
Matheson....	White Ash	Unnamed.	2	7/12/34	33.8	41.6	44.8	13.6	1.3	4.5	63.6	1.2	15.8	7220	10910	12630	2270

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TABLE 1.- Analyses of Mine Samples, Northern Colorado Coals - Continued

Where mined			Number of samples mixed and analyzed	Date sampled	Moisture, as received	Dry coal								B.t.u., as received	B.t.u., dry coal	B.t.u., ash- and moisture-free	Softening temperature, $^{\circ}$F.
County and town	Mine	Bed				Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen				
El Paso County																	
Colorado Springs.	Altitude.	A seam..	2	7/10/34	25.6	41.9	51.0	7.1	.5	4.6	67.9	1.0	18.9	8540	11480	12360	2395
Do.	City.....	Fox Hill	2	7/5/34	24.5	41.5	51.0	7.5	.5	4.7	68.1	1.0	18.2	8750	11590	12530	2330
Do.	Dixie....	A seam..	2	7/11/34	23.3	41.2	52.2	6.6	.4	5.0	70.4	1.2	16.4	9350	12190	13050	2445
Do.	Jimmy Camp.	do.	2	7/11/34	23.0	40.7	50.5	8.8	.6	4.8	68.6	1.2	16.0	9100	11820	12950	2220
Do.	New Keystone.	Unnamed.	2	7/10/34	24.7	41.8	50.8	7.4	.5	4.7	68.8	1.0	17.6	8810	11700	12640	2335
Pikeview....	Pikeview.	Fox Hill	7	6/28/34	25.8	41.9	51.8	6.3	.4	4.6	67.4	.9	20.4	8580	11550	12320	2380
Jackson County																	
Walden......	Marr.....	Sudduth.	2	7/20/34	15.9	39.6	56.8	3.6	.1	5.0	74.8	1.0	15.5	10370	12940	13420	2290
Coalmont....	Moore....	Riaach..	3	7/19/34	17.8	38.8	50.0	11.2	.4	4.8	65.8	1.9	15.9	9430	11460	12910	2605
Jefferson County																	
Leyden......	Fruth....	Unnamed.	2	6/22/34	25.5	42.1	47.9	10.0	2.0	4.7	64.2	.9	18.2	8340	11190	12430	2085
Do.	Leyden No. 3.	do.	4	5/10/34	22.0	37.8	56.5	5.7	.6	4.5	70.8	1.1	17.3	9380	12030	12760	2210
Littleton...	Unity....	do.	2	4/25/34	29.1	39.6	51.9	8.5	.6	4.4	67.4	1.1	18.0	8110	11430	12500	2205
Golden......	Van Winkle.	do.	2	4/27/34	26.7	41.8	51.6	6.6	.4	4.7	68.6	1.1	18.6	8580	11710	12530	2305
Littleton...	Virginia.	do.	2	4/23/34	26.8	40.3	51.0	8.7	1.0	4.4	67.6	1.0	17.3	8430	11520	12620	2200

TABLE 1.- Analyses of Mine Samples, Northern Colorado Coals - Continued

Where mined			Number of samples mixed and analyzed	Date sampled	Moisture, as received	Dry coal								B.t.u., as received	B.t.u., dry coal	B.t.u., ash- and moisture-free	Softening temperature, °F.
County and town	Mine	Bed				Volatile matter	Fixed carbon	Ash	Sulphur	Hydrogen	Carbon	Nitrogen	Oxygen				
Larimer County																	
Carr........	Bachy....	Unnamed.	2	4/19/34	32.4	40.0	46.5	13.5	3.0	4.5	63.6	1.4	14.0	7420	10970	12680	2250
Do.	Hackman No. 1.	do.	2	4/20/34	32.6	39.5	50.1	10.4	1.2	4.5	65.5	1.4	17.0	7490	11110	12390	2305
Weld County																	
Dacono......	Baum.....	do.	4	5/21/34	25.6	37.7	57.4	4.9	.4	4.8	73.0	1.5	15.4	9280	12480	13110	2260
Erie........	Boulder Valley (State)	do.	5	5/2/34	22.4	38.6	56.7	4.7	.3	4.9	73.0	1.7	15.4	9780	12610	13230	2090
LaSalle.....	Buddy....	do.	2	4/17/34	30.6	38.0	53.1	8.9	.5	4.8	69.3	1.6	14.9	8260	11900	13070	2230
Erie........	Clayton..	do.	4	5/8/34	22.4	37.8	57.3	4.9	.4	4.9	73.2	1.6	15.0	9810	12640	13290	2120
Serene......	Columbine	do.	4	10/26/32	22.1	39.9	54.5	5.6	.4	4.9	72.3	1.6	15.2	9800	12580	13330	2035
Frederick...	Grant....	do.	4	11/28/32	25.8	37.7	56.4	5.9	.6	4.7	72.4	1.6	14.8	9250	12470	13250	2230
Erie........	Imperial.	do.	4	5/16/34	23.4	37.3	57.0	5.7	.6	4.9	72.8	1.6	14.4	9660	12620	13380	2140
Lafayette...	Monroe...	do.	2	4/12/34	23.1	38.3	56.7	5.0	.4	4.9	73.0	1.6	15.1	9740	12660	13330	2185
Erie........	Morrison.	do.	4	5/15/34	22.2	38.6	54.6	6.8	.4	4.9	71.0	1.6	15.3	9540	12260	13160	2095
Dacono......	Puritan..	do.	4	6/11/34	23.7	37.9	56.5	5.6	.5	4.7	72.1	1.6	15.5	9580	12560	13310	2060
Frederick...	Russell..	do.	3	5/23/34	25.7	38.1	55.5	6.4	.7	4.7	71.9	1.6	14.7	9180	12350	13190	2330
Do.	Shamrock.	do.	2	4/30/34	24.7	37.6	56.3	6.1	.7	4.8	71.8	1.6	15.0	9390	12470	13280	2035
Lafayette...	Standard.	do	2	6/6/34	20.8	37.7	55.6	6.7	.5	4.9	70.6	1.2	16.1	9820	12410	13290	2055
Dacono......	Sterling.	do.	4	6/6/34	25.2	37.9	56.0	6.1	.5	4.7	71.5	1.7	15.5	9310	12450	13250	2100
LaSalle.....	Sunset...	do.	2	4/18/34	29.4	37.4	54.0	8.6	.6	4.7	69.1	1.6	15.4	8350	11840	12950	2090
Ft. Lupton..	Witherbee (Silver State)	do.	2	6/8/34	25.8	38.5	53.5	8.0	.5	4.7	68.4	1.5	16.9	8910	12010	13050	2105

TABLE 2.- Analyses of Delivered Coal; Samples Collected at Mine Tipples, Northern Colorado Coals

Where mined			Size of coal	Date sampled	Moisture, as received	Dry coal				B.t.u., as received	B.t.u., dry coal	B.t.u., ash- and moisture-free	Softening temperature, °F.
County and town	Mine	Bed				Volatile matter	Fixed carbon	Ash	Sulphur				
Boulder County													
Erie.......	Arrow (Star).	Unnamed.	2-inch slack..........	4/6/34	23.7	34.4	53.1	12.5	1.1	8840	11590	13250	2230
Lafayette...	Black diamond.	do.	6- to $2\frac{1}{2}$-inch nut coal.	3/27/34	19.9	38.4	56.0	5.6	.5	9990	12470	13220	2110
Gorham......	Crown....	do.	$2\frac{1}{2}$-inch slack.........	4/3/34	18.4	37.8	55.9	6.3	.4	9980	12230	13060	2060
Do.	Eldorado.	do.	6-inch lump...........	3/14/34	17.0	38.5	55.4	6.1	1.7	10220	12300	13100	2020
Superior....	Gorham...	Gorham..	do.	3/9/34	18.9	38.4	56.1	5.5	.4	10130	12490	13210	2130
Do.	Industrial.	Unnamed.	do.	11/17/32	18.5	41.3	53.2	5.5	.3	10170	12480	13200	2100
Do.	do.	do.	6- to $2\frac{1}{2}$-inch nut coal.	11/14/32	17.7	39.2	55.0	5.8	.2	10200	12390	13150	2090
Do.	do.	do.	Under $2\frac{1}{2}$-inch slack....	11/12/32	17.0	36.3	54.5	9.2	.4	10050	12110	13340	2190
Gorham......	Lewis No. 2.	do.	6-inch lump...........	3/19/34	16.3	39.5	55.6	4.9	1.1	10550	12600	13250	2360
Broomfield..	Monarch No. 2.	do.	$2\frac{1}{2}$-inch slack (crushed)	6/19/34	16.0	37.8	55.5	6.7	.4	10250	12200	13080	2110
Superior....	Pluto....	do.	6-inch lump...........	3/9/34	18.9	37.2	57.1	5.7	.3	10090	12440	13200	2090
Gorham......	Rosser...	do.	do.	3/16/34	16.5	38.5	56.6	4.9	1.0	10500	12570	13220	2280
El Paso County													
Colorado Springs.	City.....	Fox Hill	Pea slack under 1 inch.	7/7/34	21.4	40.7	45.4	13.9	.4	8390	10670	12400	2180
Pikeview....	Pikeview.	do.	Crushed run-of-mine....	7/2/34	22.0	41.6	51.3	7.1	.4	8890	11400	12270	2270

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TABLE 2.- Analyses of Delivered Coal; Samples Collected at Mine Tipples, Northern Colorado Coals - Continued

Where mined			Size of coal	Date sampled	Moisture, as received	Dry coal				B.t.u., as received	B.t.u., dry coal	B.t.u., ash- and moisture-free	Softening temperature, °F.
County and town	Mine	Bed				Volatile matter	Fixed carbon	Ash	Sulphur				
Jefferson County													
Leyden......	Leyden No. 3.	Unnamed.	Egg under 6-, over 2½-inch.	5/11/34	20.0	38.3	55.2	6.5	0.6	9540	11920	12750	2140
Do.	do.	do.	Under 2½-inch slack......	5/14/34	20.1	39.2	53.8	7.0	.7	9500	11890	12790	2090
Littleton...	Virginia.	do.	-1¼- and +½-inch steam or nut.	4/24/34	23.4	39.6	50.7	9.7	.9	8690	11330	12560	2140
Weld County													
Erie........	Boulder Valley (State).	do.	-2½-inch slack..........	5/4/34	21.9	38.6	56.8	4.6	.4	9890	12660	13280	2080
Do.	Clayton..	do.	Egg (nut) under 6-, over 2½-inch.	5/9/34	20.0	37.8	56.4	5.8	.4	10030	12530	13300	2050
Serene......	Columbine	do.	6-inch lump.............	10/31/32	20.7	37.8	56.4	5.8	.3	9980	12580	13350	2040
Do.	do.	do.	Pea coal, 2½- by 1¼-inch.	11/1/32	19.7	38.5	54.6	6.9	.3	9960	12410	13330	2050
Do.	do.	do.	Slack under 1¼-inch......	10/26/32	20.4	38.1	53.9	8.0	.4	9770	12270	13340	2140
Frederick...	Grant....	do.	4-inch lump.............	12/23/32	24.0	36.8	57.5	5.7	.6	9550	12570	13330	2200
Do.	do.	do.	Slack under 1½-inch......	12/19/32	25.2	38.2	54.7	7.1	.8	9240	12350	13290	2170
Erie........	Imperial.	do.	2½-inch slack crushed....	6/21/34	19.9	37.6	56.7	5.7	.5	9980	12460	13220	2130
Lafayette...	Monroe...	do.	Slack under 2½-inch......	4/13/34	20.2	37.0	54.3	8.7	.5	9680	12130	13290	2160
Erie........	Morrison.	do.	2½-inch slack (crushed)..	5/17/34	20.3	38.4	54.3	7.3	.5	9660	12120	13070	2090
Frederick...	Russell..	do.	2½-inch slack...........	5/24/34	23.7	38.7	53.9	7.4	.7	9380	12290	13270	2130
Do.	Shamrock.	do.	-2½-inch slack..........	5/1/34	20.5	37.0	57.2	5.8	.6	10050	12640	13430	2080
Dacono......	Sterling.	do.	2½-inch slack(crushed)...	6/12/34	22.0	37.3	55.2	7.5	.6	9600	12300	13290	2050

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